Is Intervertebral Cement Leakage a Risk Factor for New Adjacent Vertebral Collapse?

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Summary

This retrospective study evaluated the relationship between intervertebral cement leakage and new adjacent vertebral fracture and describes the different characteristics of cement leakage.

Increased risk of new adjacent vertebral fracture (NF) has been reported to be a complication of cement leakage in vertebroplasty. In our observation, an incidental intervertebral cement leakage may occur during vertebroplasty but is commonly asymptomatic.

The study focused on osteoporotic collapse patients who had percutaneous vertebroplasty (PV) between 2005 and 2007. We divided patients into leakage and non-leakage groups and compared the incidence of NF. Leakage characteristics were divided into three types: Type I intervertebral-extradiscal leakage, Type II intradiscal leakage and Type III combined leakage. Visual analog scale for pain and the Karnofsky Performance Status at 24 h, three months, six months and one year were compared between groups and types of leakages. Among 148 PVs (102 patients) there were 30 leakages (20.27%) and 21(14.19%) NFs. The incidence of NF did not significantly differ between leakage and non-leakage groups (P<0.05). Type II was the most common type of leakage (15/30). Reduction of average pain and improvement of Karnofsky Performance Status score did not differ between groups (P< 0.05). Type II had decreased pain score < type I and III at 24 h (P < 0.01), three months and six months (P < 0.1) but not at one year (P<0.10). Type II also had decreased pain score < non-leakage group only at 24 h (P<0.05).

Intervertebral cement leakage is not an increased risk for NF, influenced outcomes of pain relief or improvement of physical function. Intradiscal leakage (Type II) is the most common characteristic of cement leakage and probably related to delayed pain relief.

Introduction

Percutaneous vertebroplasty (PV) is known to be the effective treatment of painful osteoporotic collapse [1-15]. However, new adjacent vertebral fracture (NF) has been reported to be a complication of this procedure [16,17] due to increased stiffness of the treated vertebral body and reported associated cement leakage into the disk [16]. In our observation, incidental intervertebral cement leakage may occur during PV and can present differently in shape, location and extension but is commonly asymptomatic. Our study aimed to evaluate the relationship between cement leakage during vertebroplasty and NF and to describe the different characteristics of cement leakage.

Materials and Methods

Patients

Following local university hospital ethics board approval, a retrospective study was performed in all patients with osteoporotic vertebral collapse patients who had PV between February 2005 and October 2007. Patients with

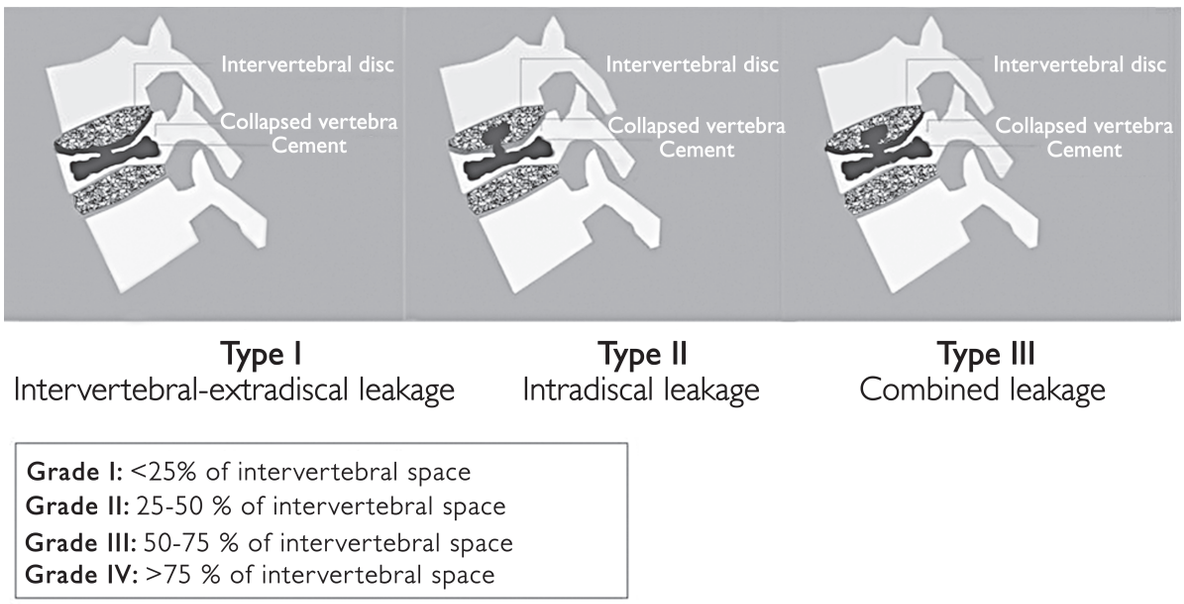

Figure 1 Types of cement leakage and grading.

other known causes of vertebral collapses (e.g., metastasis, vertebral hemangioma, multiple myeloma or trauma) were excluded. Inclusion criteria were met by 102 patients with 148 consecutive PV procedures. All patients were informed of the risks and benefits of the treatment and all provided written informed consent before PV. Characteristics of the patients are listed in Table 1.

Indication for PV was painful vertebral collapse fracture without evidence of neurological deficit failing to respond to conservative treatment, defined as minimal or no improvement of pain after adequate analgesic administration and physical therapy for two weeks. Pre-procedural plain radiographs or magnetic resonance images were obtained, and correlated with complete history-taking and physical examination to localize the area of maximal pain to plan the treated level before therapy.

Procedure

PV was performed under conscious sedation according to the technique described by Buchbinder et al.[18]. One gram of intravenous cefazolin was administered 20 minutes before the procedure. The patients were placed on a biplane angiography table (Allura Xper, Philips Healthcare). Electrocardiographic readings, blood pressure and oxygen saturation were monitored continuously. The involved vertebra/vertebrae were identified fluoroscopically and the overlying skin was prepared and draped in the usual sterile fashion. Local anesthesia was infused into skin and deep soft tissue, including the periostium of the treated bone. Under fluoroscopic guidance, an 11-13 gauge bone biopsy needle (Osteo-SiteR, William Cook Europe, Bjaeverskov, Denmark) was directed into the anterior third of the vertebral body by gentle taps with an orthopedic hammer via unilateral transpedicular or bilateral transpedicular approach. Intraosseous venography was performed through the second bone biopsy needle to confirm the position and then radiopaque bone cement (Osteo-FirmTM, William Cook Europe, Bjaeverskov, Denmark; a combination of methylmethacrylate monomer liquid, and polymethylmethacrylate copolymer powder containing barium sulfate as an opacifier) was injected into the VB with one ml syringes through the bone biopsy needle under close fluoroscopic guidance. The injection was terminated when the cement reached the posterior third of the VB or when paravertebral or epidural venous filling was seen. A post procedural CT scan or plain radiographs of the treated levels were performed all patients on the same day or the next day to evaluate cement filling in the vertebral body and cement extravasations. The patients were discharged 24-48 hours after procedure.

Pre and post procedural evaluation

The patient's pain level was assessed before and 24 hours after vertebroplasty with the use of a visual analog scale (VAS) ranging from 0 (no pain) to 10 (worst pain). The Karnofsky Performance Status (KPS) was used for objective assessment of patients' quality of life before and 24 hours post vertebroplasty was newly graded into 1-3 general category (1=able to carry on normal activity, no special care needed; 2=unable to work, able to live at home and care for most personal needs, varying amount of assistance needed; 3=unable to care for self, required institutional or hospital care or equivalent, disease may be rapidly progressing) from prior 0-100 severity index (80-100 = category 1; 50-70=category 2; 0-40=category 3). Telephone follow-up was used to assess each patient in VAS and KPS at three months, six months, one year and at present.

Review of data

The medical records were reviewed and the new fractures were evaluated from the imaging follow-up. We divided patients into two groups (leakage and non-leakage) and compared the incidence of new fractures between these groups. We classified leakages on their characteristics into three types (Figure 1): Type I intervertebral-extradiscal leakage, Type II intradiscal leakage and Type III combined leakage (Figure 1). Leakage was divided into four grades: Grade I <25% of intervertebral space, Grade II 25-50% of intervertebral space, Grade III 50%-75% of intervertebral space, Grade IV >75% of intervertebral space. The locations of leakages were grouped into upper, lower and both. Images of leakages and new adjacent fractures were reviewed and classified by three radiologists with interobserver concordance. Patients' VAS KPS at 24 hours, three months, six months and one year were analyzed and compared between groups and types of leakage.

Statistical analysis

We compared the incidence of new adjacent fractures between leakage and non-leakage groups, pre and post procedural pain score and KPS, using repeated measures ANOVA, independent paired t-test. Analyses were performed using the SPSS statistical software (Version 15.0, SPSS Inc., Chicago, IL, USA). A P value of less than 0.05 was considered significant. The literature review was obtained to compare our outcome with those of other groups. Literature was searched from Pubmed libraries on electronic databases.

Results

Among 148 vertebroplasty in 102 patients (14.7% male and 85.3% female with a mean age of 73.75 years), there were 30 intervertebral leakages (20.27%) and 21(14.19%) new adjacent fractures (Tables 1 and 2). The incidence of NF (Figure 2) did not significantly differ between the two groups (P<0.05). Three fractures were found in the intervertebral leakage group and 18 fractures in the non-leakage group. Type II was the most common type of intervertebral leakage (15/30), following by type I (8/30) and type III (7/30) (Figure 3). Most types I and II had Grade I leakage (75% of type I and 93.35% of type II), while most type III had Grade II leakage

Table 1 **Descriptive characteristics of patients.**

	Cement leakage (n=26)	No cement leakage (n=76)	Total (n= 102)
Average age	72	74	73.75
Range	49-97	49-93	49-97
Male	7	8	15
Female	19	68	87

Table 2 **Incidence of new fracture in relation to cement leakage (n=148 vertebroplasty), statistically significant, P < 0.05.**

	Cement leakage (n=30)	No cement leakage (n=118)	Total (n= 148)
New fracture	3	18	21
No New fracture	27	100	127

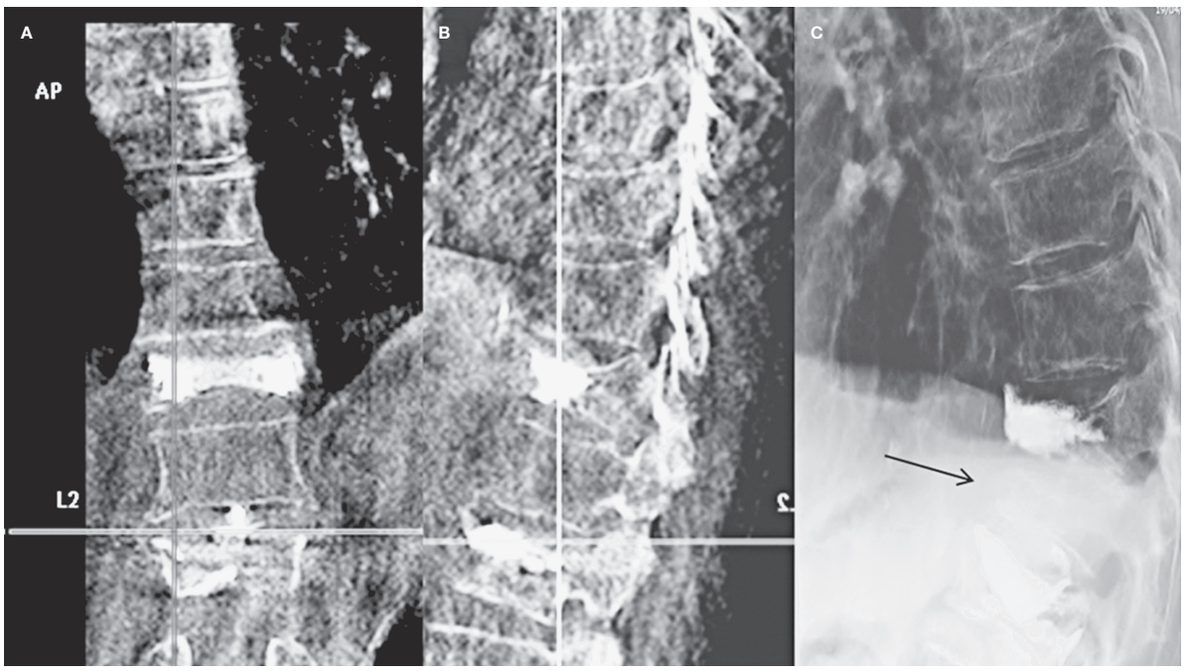

Figure 2 A,B) Cement leakage at L2-L3 intervertebral space (type II). C) New adjacent vertebral fracture (arrow) occurred 1 month after vertebroplasty.

(71.43%). Among NF in the leakage group, two were found in type II and one was found in type I and all of them had Grade I (Table 3) No NF were adjacent to the site where cement leaked.

The location of cement leakage was found mostly in the upper intervertebral space (50% of type I, 66.67% of type II and 100% of type III) (Table 3). Patient outcome of post vertebroplasty in term of reduction of average VAS for pain and improvement of KPS score at 24 h, three months, six months and one year did not differ between leakage and non-leakage groups ($P< 0.05$) (Figure 4) (Table 4). Among types of leakage, type II had a significantly decreased pain score less than type I and III at 24 h ($P < 0.01$), three months and six months ($P < 0.1$) but not at one year ($P<0.10$) (Table 4). Type II also had decreased pain score less than the non-leakage group only at 24 h ($P<0.05$). KPS had no difference at any observation time ($P<0.05$) (Figure 5).

Discussion

Increased stiffness of treated vertebra after vertebroplasty may result in a new adjacent vertebral fracture (NF) [17,19]. Leakage of cement into the disc has been proposed to increase the incidence of NF [16,17]. Increased stiffness at the leaked region and additional potential force to the non-treated vertebra has been thought to be the cause. In our study, the incidence of NF after PV did not significantly differ between cement leakage and non-cement leakage groups ($P< 0.05$). The reason for this might be related to the amount of intervertebral cement leakage and extension, which was not large enough to have a significant impact on the non-treated vertebra. We noticed that cement leakages in our patients were not directly in contact with the endplate of new fractures. Furthermore, other uncontrolled factors such as increased patient physical activity after pain relief, degree of osteoporosis and natural history of osteoporosis [20] are all able to evenly create NF in both groups. We felt in the same way as a previous study that the adjacent osteoporotic vertebrae would fracture eventually, even without the procedure [20].

From our observation, leakage of cement in the intervertebral region could be located either inside or outside the disc, in between disc and endplate. The most common cement leakage found in our study was type II (intradiscal leakage) which may be related to degenerative changes in disc and endplate common in the el-

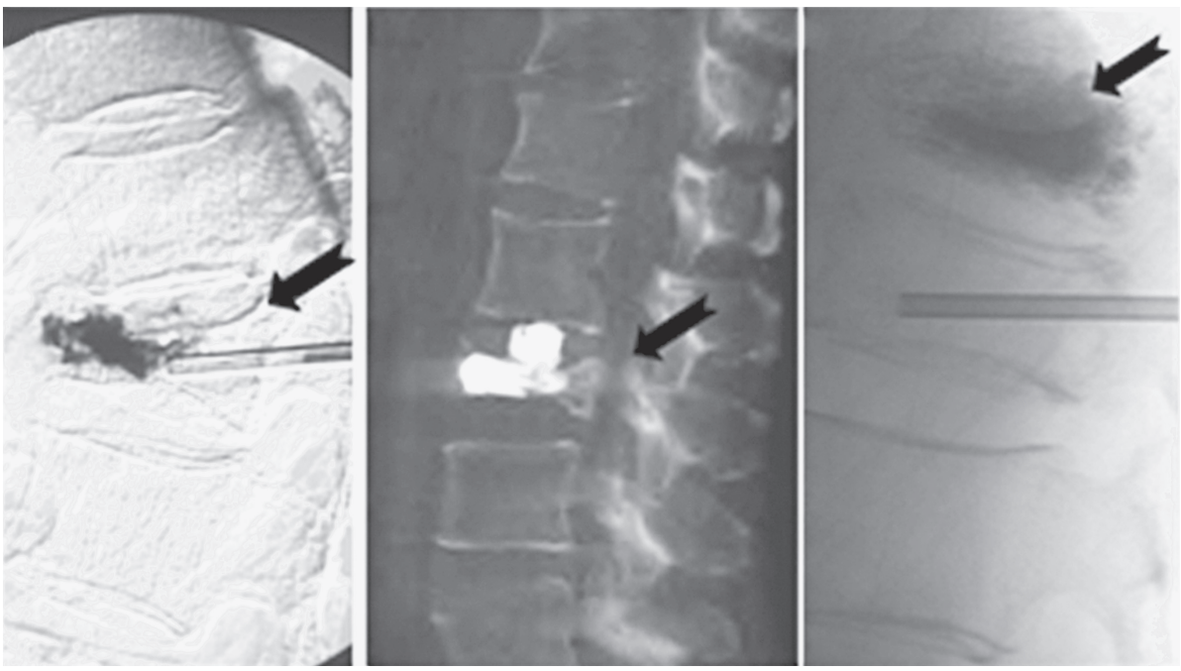

Figure 3 Leakages during percutaneous vertebroplasty. A = type I, B = type II, C = type III.

derly. In relation to pathologic examination, an aged disc particularly its nucleus will become less gelatinous and more fibrous, crack and form fissures. Aged cartilage endplate will undergo thinning, altered cell density, and formation of fissures. Old subchondral bones will undergo sclerosis [21]. We speculated that those changes might affect the process of cement infusion. Despite careful injection of cement through the needle placed in the proper position, the inadvertently leaked cement could be passed through degenerative endplates and tended to move to the central portion of the disc. In addition, a prior study on the systematic density and structural patterns inside the vertebral body proposes that the weak part was in the upper half of the body [22]. Our study supported this theory as in our study most leakages occurred at this location.

Nevertheless, a new randomized trial of vertebroplasty postulated that pain reduction in patients treated with vertebroplasty was similar to a control group [23]. The effectiveness of this treatment method was proved again and also

Table 3 **Types of cement leakage and associated findings.**

Types of leakages		Type I	Type II	Type III
Number		8	15	7
Grading	**I**	6	14	0
	II	2	1	5
	III	0	0	2
	IV	0	0	0
Location	**Upper**	4	10	7
	Lower	4	3	0
	Both	0	2	0
Adjacent fracture		1	2	0

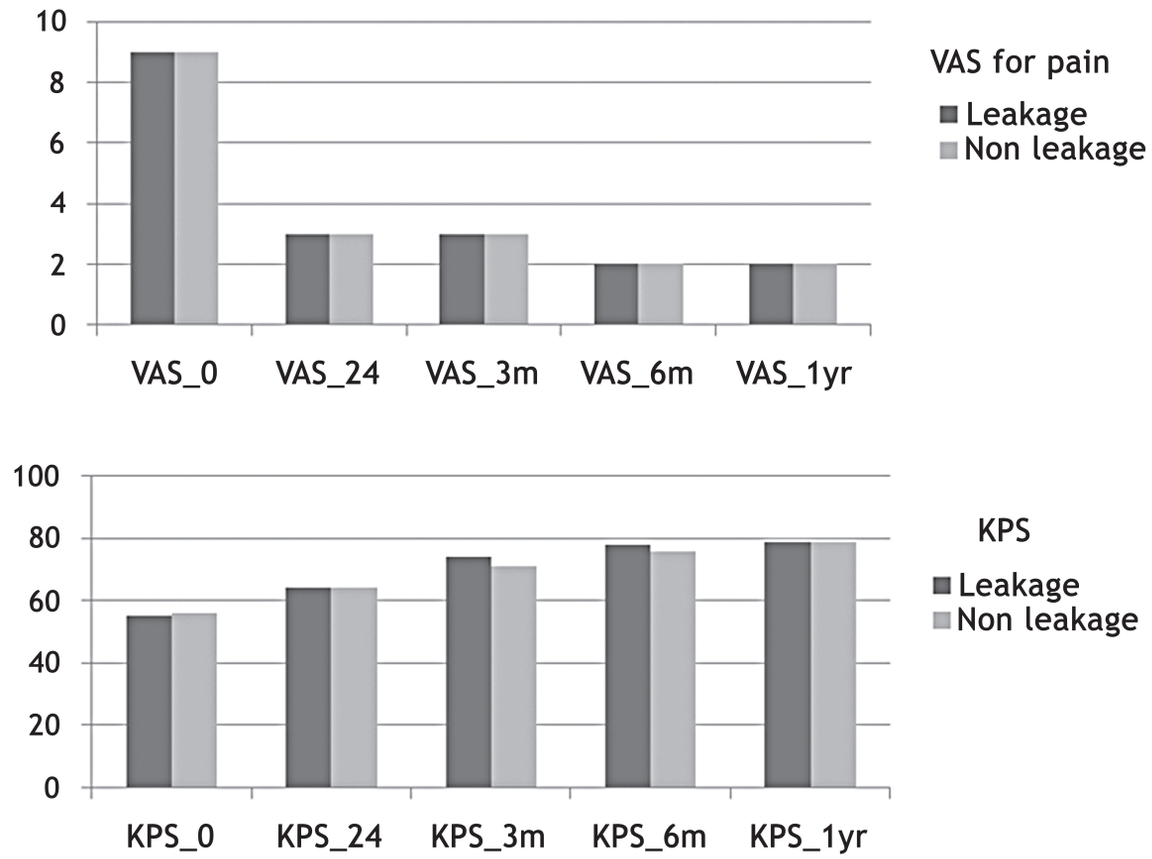

Figure 4 Comparison of VAS for pain and KPS between leakage and non-leakage groups.

Table 4 **Main characteristics of 31 patients with symptomatic unilateral and bilateral carotid artery lesions**

	Non leakage	Leakage	Type I	Type II	Type III	Significance
Pain score						
Mean_PS_0	9	9	9	9	9.5	NS
Mean_PS_24 hours	3	3	3	5a	2.14	P<0.01
Mean_PS_3 months	3	3	2	3a	1.4	P<0.10
Mean_PS_6 months	2	2	1	3a	1	P<0.1
Mean_PS_1year	2	2	1	2	1.57	NS
Karnofsky Performance status (KPS)						
Mean_KPS_0	56	55	56	54	54	NS
Mean_KPS_24 hours	64	64	70	62	61	NS
Mean_KPS_3 months	71	74	76	73	74	NS
Mean_KPS_6 months	76	78	80	75	80	NS
Mean_KPS_1 year	79	79	81	76	80	NS

NS= not significant
a = statistically significant

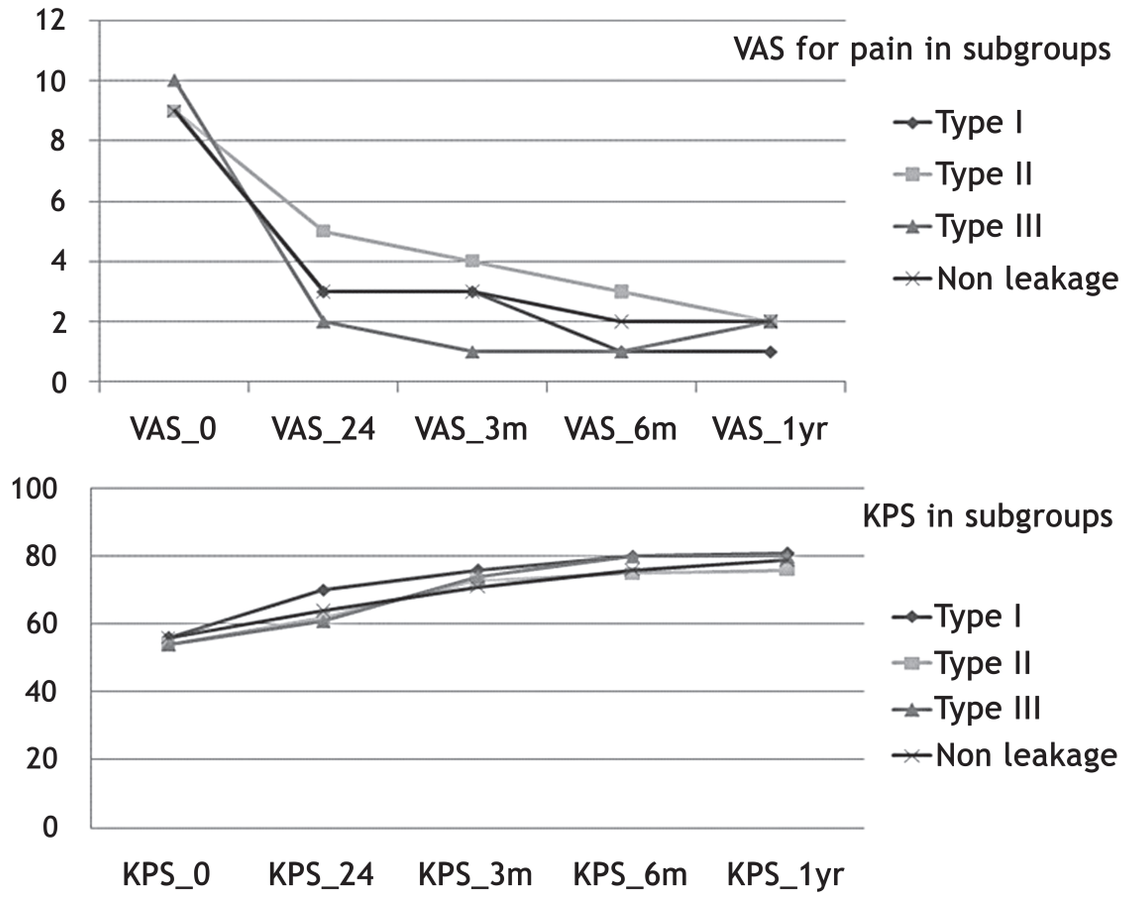

Figure 5 Comparison of VAS for pain and KPS among types and non-leakage group.

reported in many retrospective studies in the literature [1-15]. Moreover, improvement of pain and KPS score at 24 h, three months, six months and one year were similar between leakage and non-leakage groups ($P< 0.05$). We assume that the mechanism of pain relief probably does not differ between groups, and was due to the effects of heat and stability of the spine. In contrast, the maintenance of pain in daily life is likely to depend on the uncontrolled factors mentioned above. Among types of leakage, type II had a significantly decreased pain score less than type I and III at 24 h ($P < 0.01$), three months and six months ($P < 0.1$) but not at one year ($P<0.10$). In addition, type II had a decreased pain score less than the non-leakage group only at 24 h ($P<0.05$). We consider that type II leakage may relate to delayed pain relief especially in case of multilevel PVs with multileakages, the treated vertebra which has type II leakage may delay decreasing pain compared with the other treated vertebrae which have type I or III leakages during one year after treatment.

Comparing vertebroplasty and kyphoplasty, the advantage of kyphoplasty in lowering the risk of cement leakage causing NF has been reported [7,24-29]. However, our findings showed no relationship between cement leakage and an increasing risk of NF or a difference in pain relief in either leakage or non-leakage groups. If a percutaneous treatment is indicated after failed medication, PV would be suggested by us to be the primary treatment and treatment of choice for painful osteoporotic collapse according to its good result, short procedure time and reduced cost.

The limitations of our study include an unequal number of NF in leakage and non-leakage groups and the small number of NF in the leakage group that prevented us classifying the significant relation in each type of leakage.

Conclusion

The incidence of NF after PV did not significantly differ between cement leakage and non-cement leakage groups (P< 0.05). The adjacent osteoporotic vertebrae would fracture eventually, even without the procedure.

Improvement of pain and KPS score at 24 h, three months, six months and one year was similar between leakage and non-leakage groups (P< 0.05).

The most common cement leakage found in our study was type II (intradiscal leakage) and the treated vertebra with type II leakage may delay a decrease in pain compared with the other treated vertebrae with type I or III leakages during one year after treatment.

Key Messages

Intervertebral cement leakage is generally asymptomatic and does not carry an increased risk for new adjacent vertebral fracture. Cement leakage neither influences nor predicts outcomes of pain relief and improvement of physical function. With our observation, intradiscal leakage (Type II) is the most common characteristic of cement leakage into the intervertebral space and probably related to delayed pain relief.

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